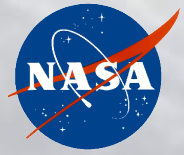

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What can we learn from 11 years of AIRS observations?

Eric J. Fetzer

Jet Propulsion Laboratory / California Institute of Technology

AIRS Science Team Meeting Caltech

March 18, 2014

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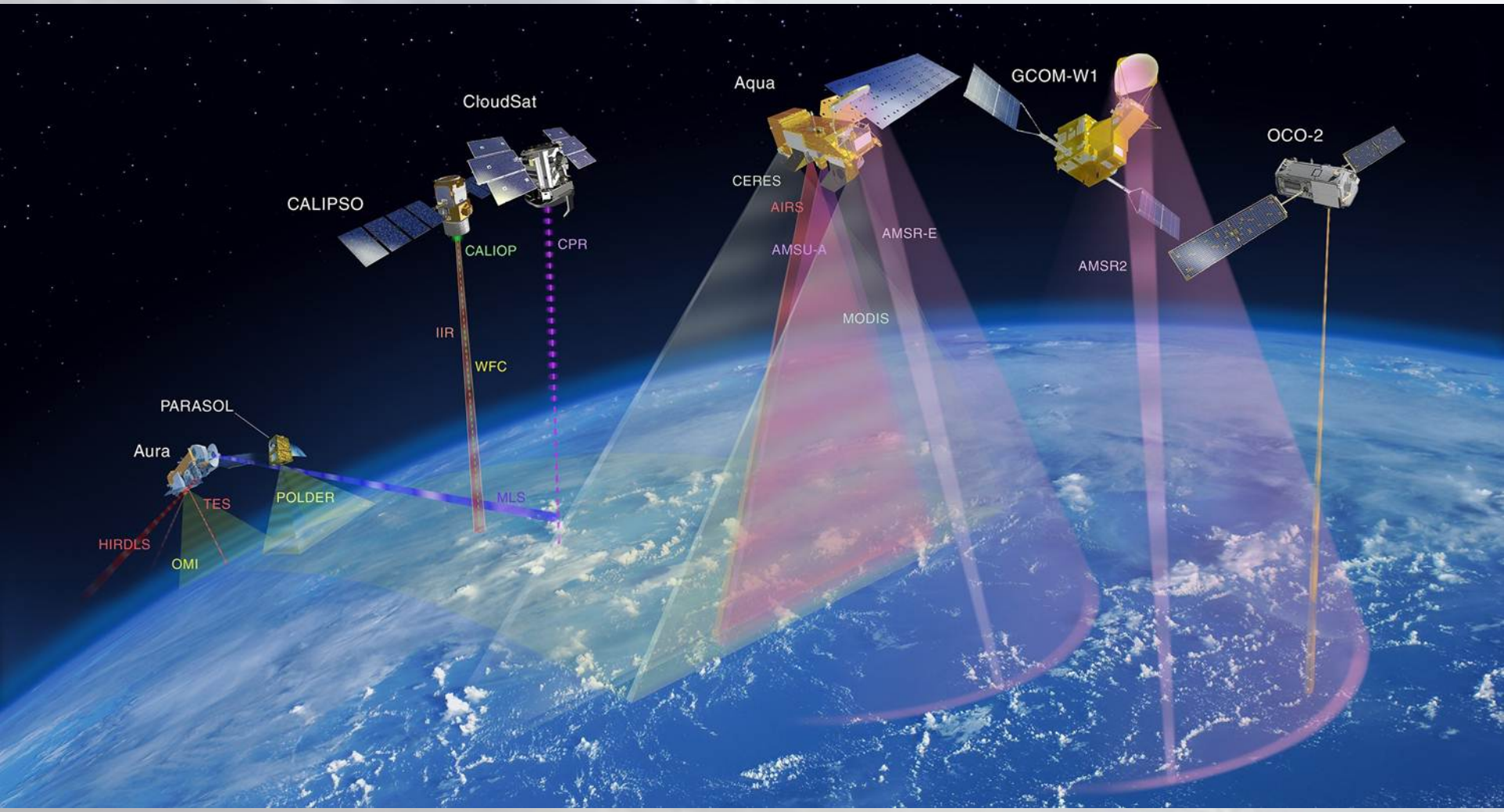
We are not alone…



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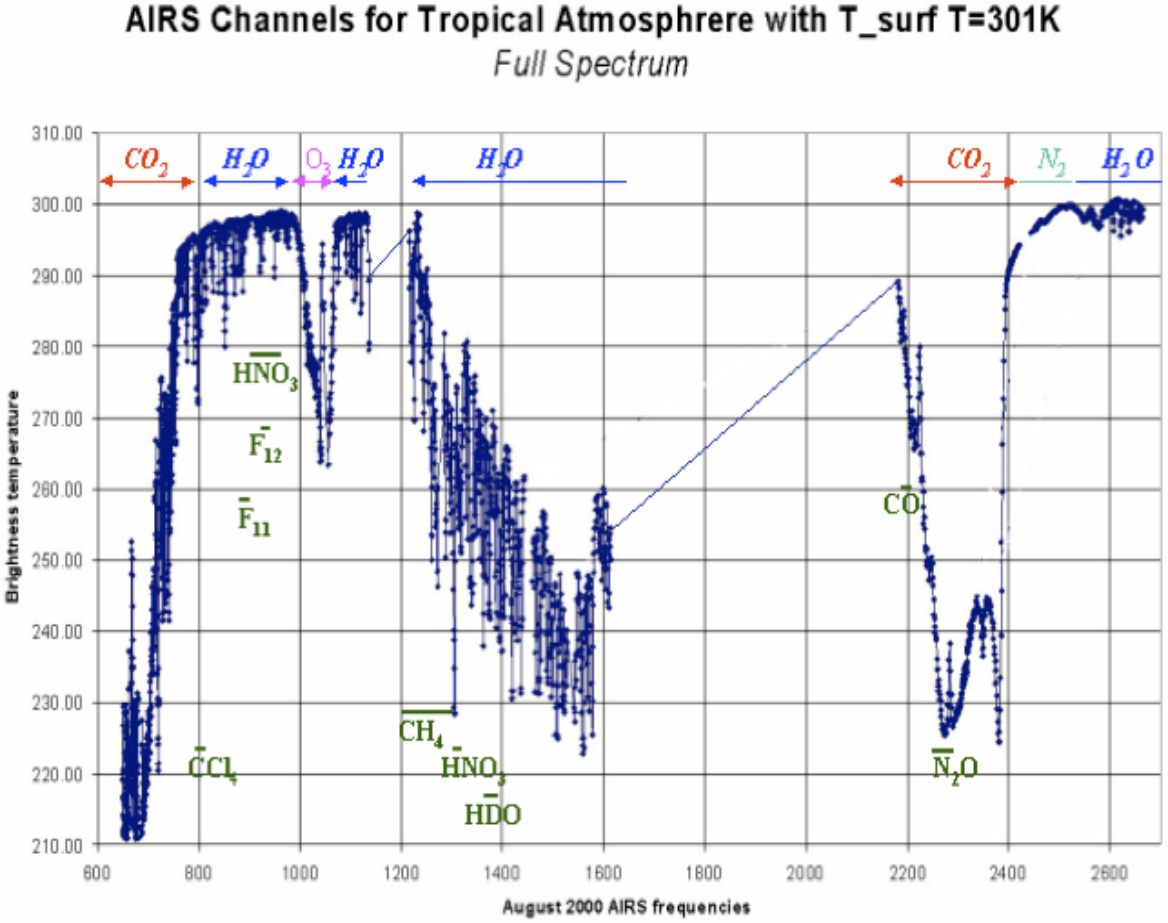
2.9 Million Daily Spectra



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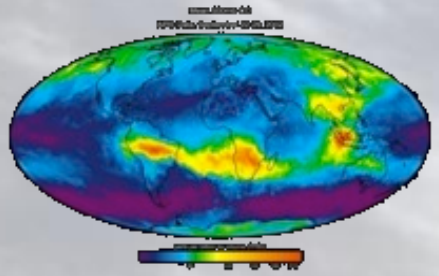
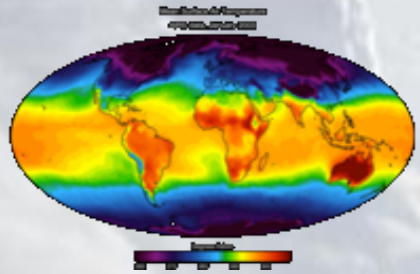
AIRS Key Products

Clouds and Water Vapor Feedback

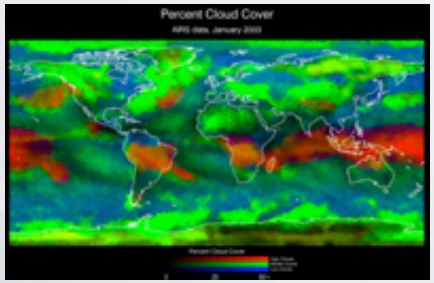
CO



Atmospheric Temperature

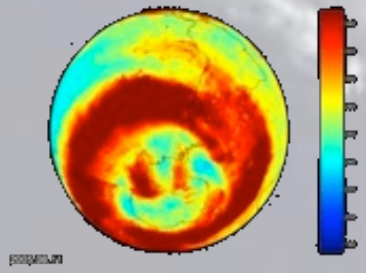


Cloud Properties

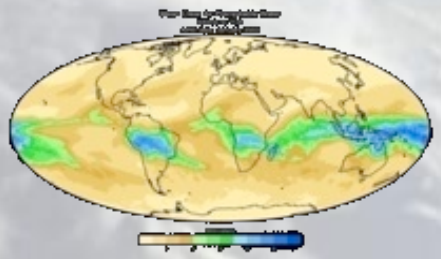


Greenhouse Gas Forcing

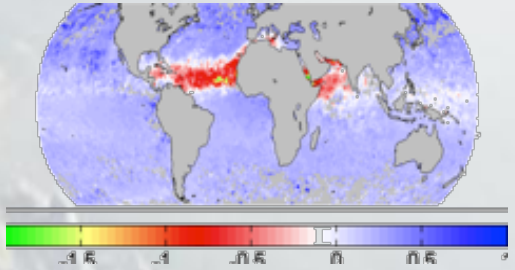
Ozone



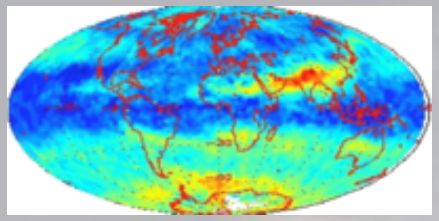
Atmospheric Water Vapor



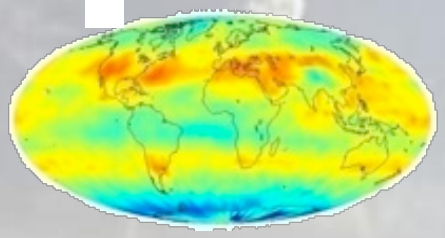
Dust



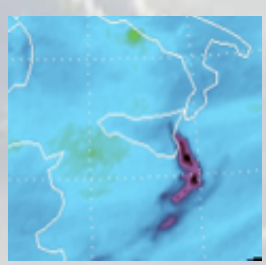
Methane



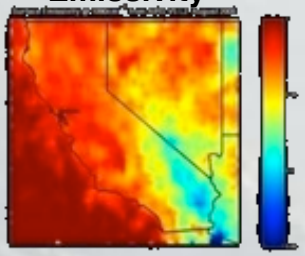
CO2



SO2



Emissivity



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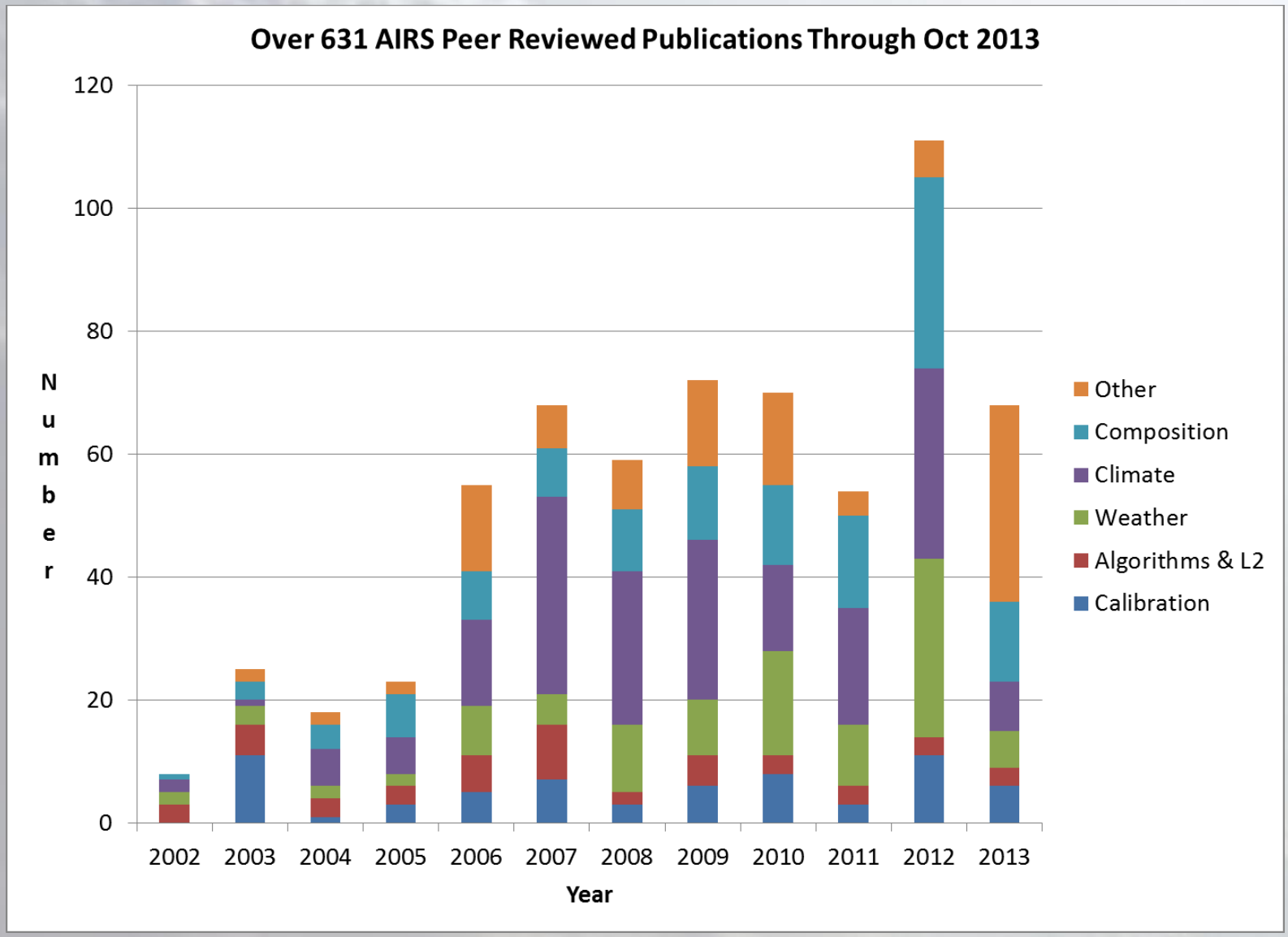
Many published AIRS studies
An order of magnitude more talks



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The Strengths of AIRS

- **Closer to pure observations than reanalyses**
  - ***Heed Graeme Stephens' comments yesterday about reanalyses.***
- **High infrared spectral resolution and coverage**

  => highest vertical resolution from the IR.
- **Information about temperature and water vapor profiles, trace gases, etc. obtained simultaneously**
  - ***Especially important for water vapor-lapse rate feedbacks.***
- **Global coverage.**
- **11+ years of data (10 billion spectra, 1 billion retrievals).**

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AIRS Challenges

- **In cloudy scenes most information is obtained in the microwave**
  - ⇒ ***Lower vertical resolution than IR.***
- **Global coverage.**
- **11+ years of data (10 billion spectra, 1 billion retrievals).**

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Exploiting AIRS Strengths

- **Examine:**
  - ***Ways to distinguish tropics and extratropics.***
    - Use a potential temperature threshold
  - ***Driest scenes in the tropics***
    - Because AIRS can distinguish profiles there easily.
  - ***Develop metrics for long-term variability***

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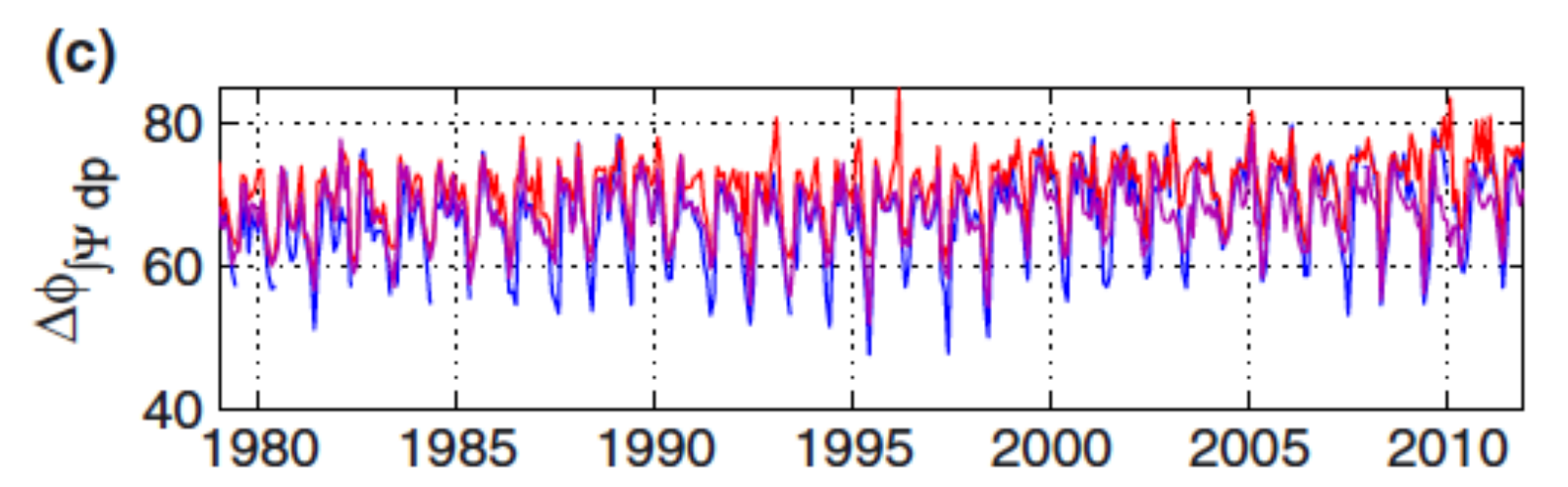
Some Motivation

- **Important cloud-related feedbacks occur in the dry subtropics**
  - ***Fasullo & Trenberth, 2012, A Less Cloudy Future: The Role of Subtropical Subsidence in Climate Sensitivity, Science.***
  - ***We (arguably) have the best data set of temperature and water vapor in the dry subtropics.***
- **The tropics are known to be expanding because of warming. For example:**
  - *Davis, N. A., and T. Birner (2013), Seasonal to multidecadal variability of the width of the tropical belt, J. Geophys.Res. Atmos., 118, 7773–7787, doi:10.1002/jgrd.50610.*



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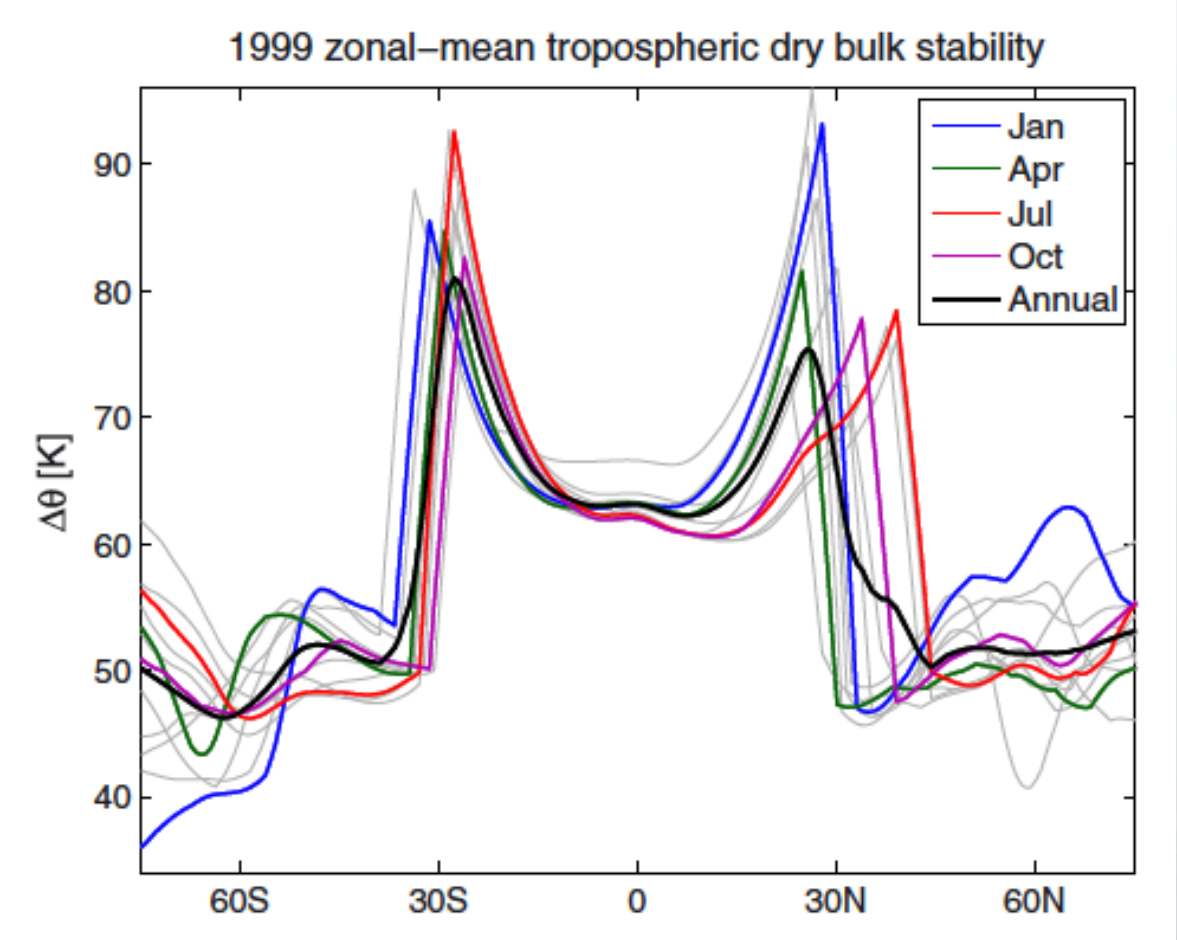
The transition to tropics is abrupt

"The bulk stability is defined here as the total difference in potential temperature between the tropopause and the surface and represents a simple measure of stability within a layer irrespective of thickness, as opposed to static stability which measures the local stratification.'

-- Davis & Birner

Right: From ERA-i.



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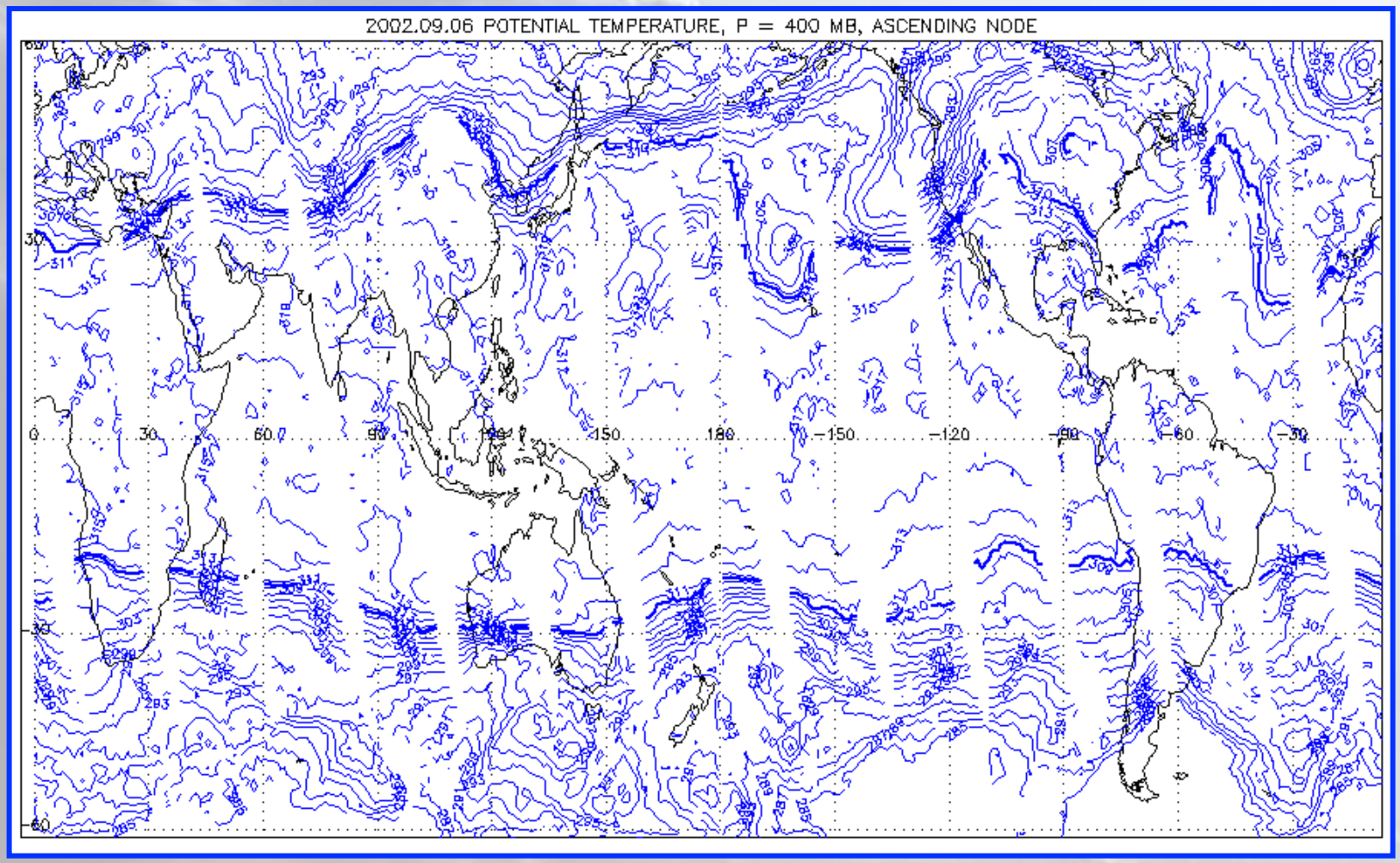
Defining Tropical Conditions at 400 hPa:
Potential Temperature > 310 K
6 Sep 2002



Level 3 Data

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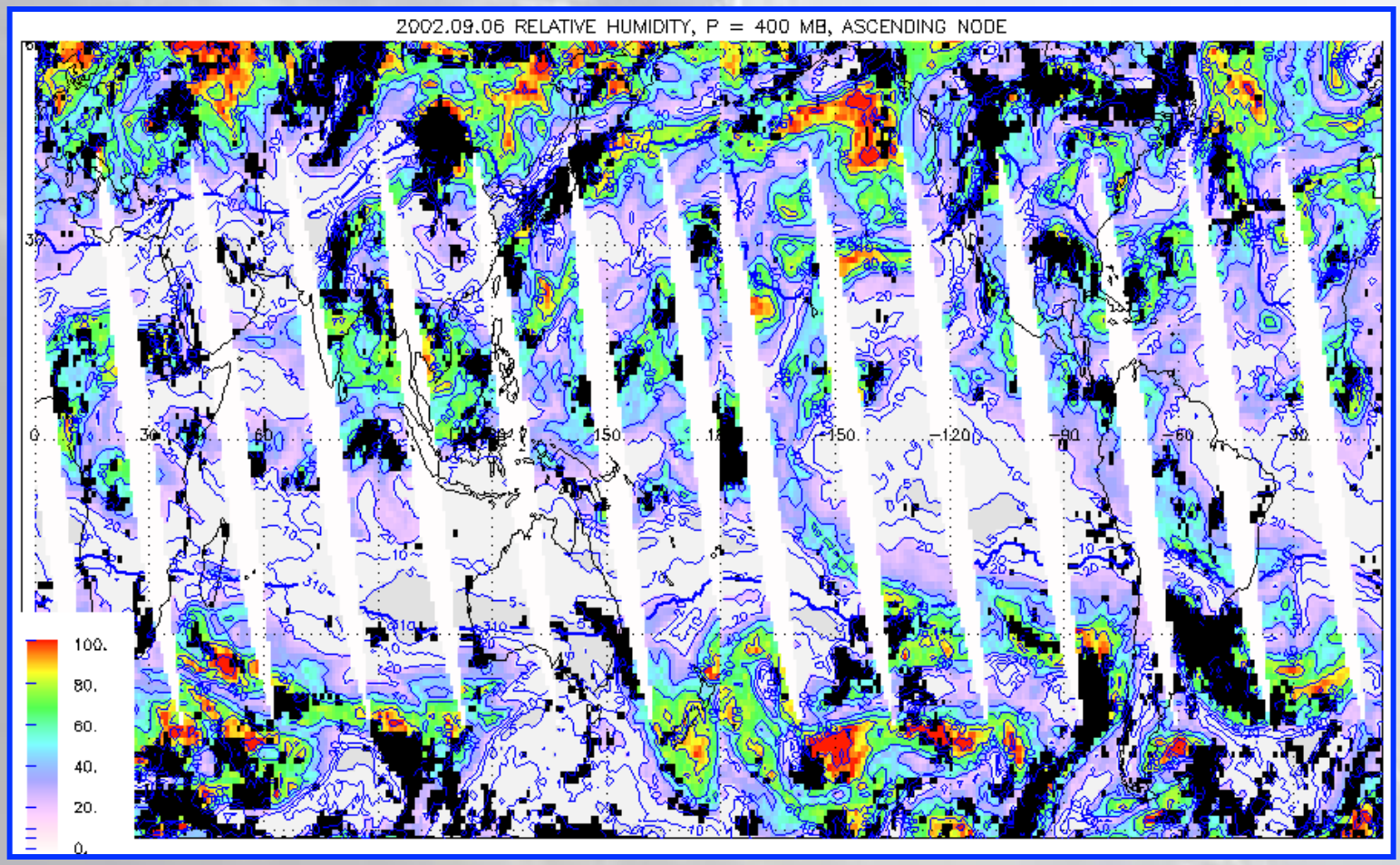
Exploiting AIRS Strengths: Dry Scenes

Relative Humidity at 400 hPa

6 Sep 2002

-Extremely demanding quality control (<100% yield for 1x1° boxes in black).
-310 K potential temp. in bold blue.



Level 3 Data

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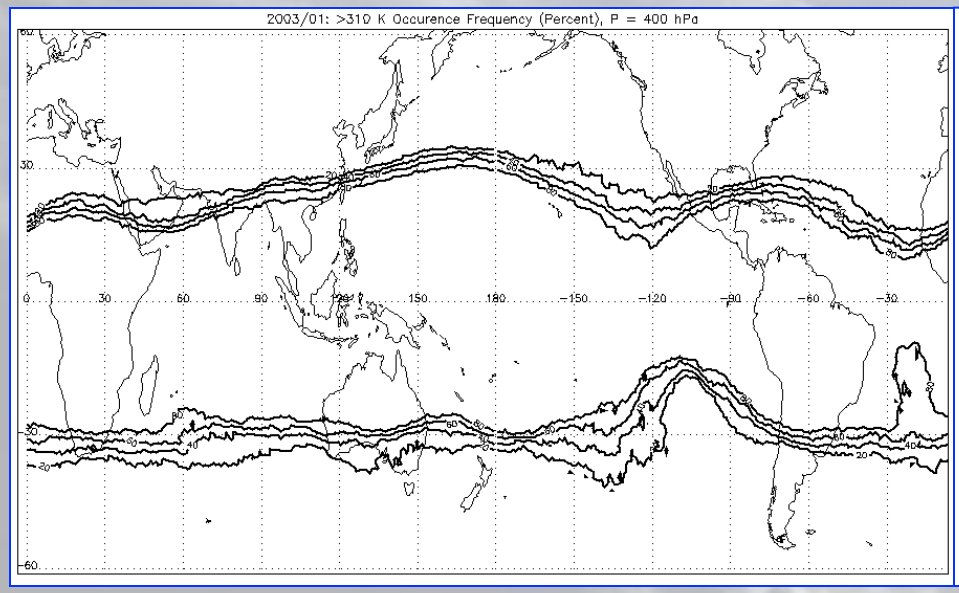
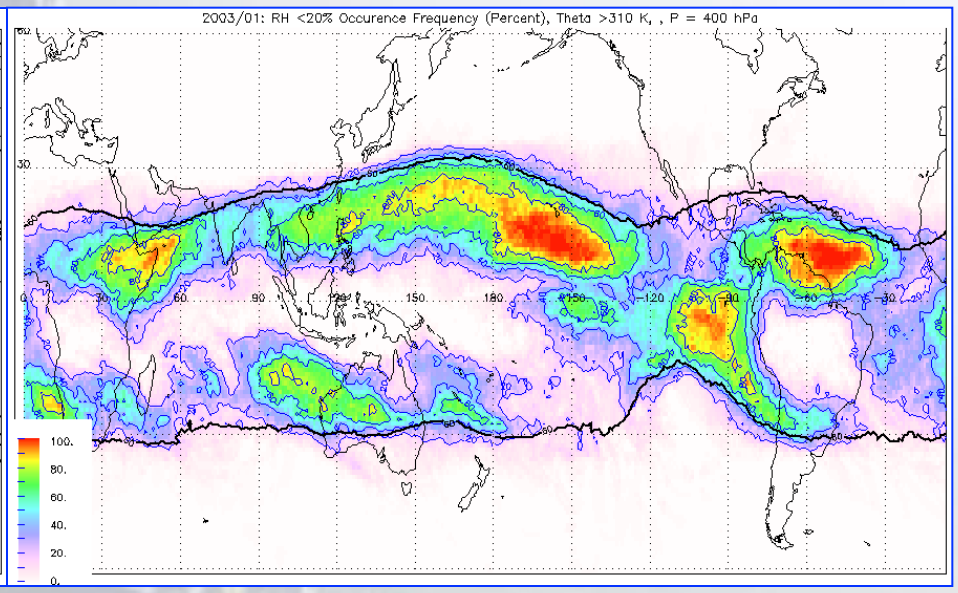
'Tropical' Conditions
January 2003





Occurrence Frequency, θ > 310 K at 400 hPa
Contours are 20, 40, 60, 80, 0%

Occurrence Frequency,
Relative Humidity < 20% at 400 hPa
(NOT mean RH)

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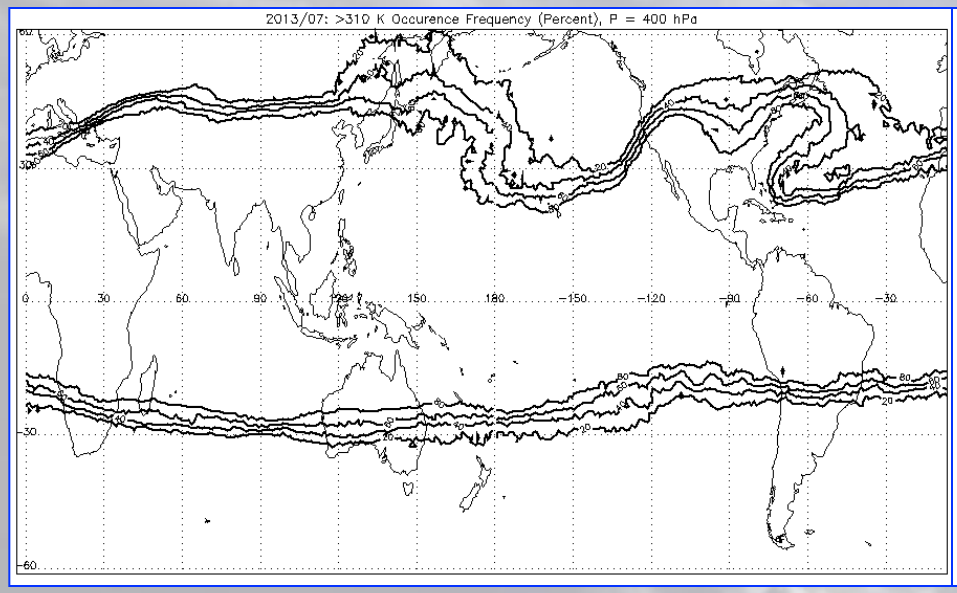
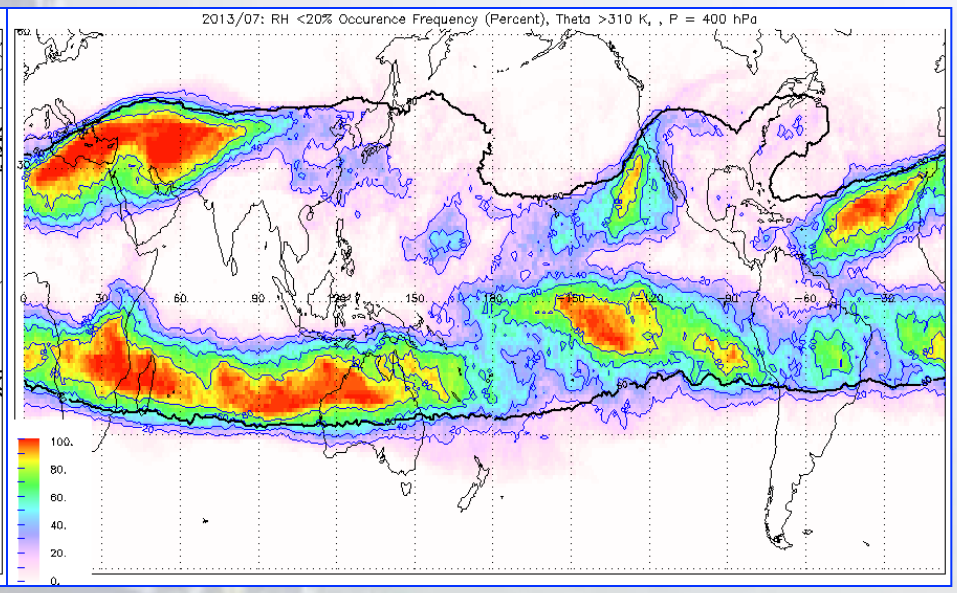
Defining 'Tropical' Conditions Dynamically
July 2013





Occurrence Frequency, θ > 310 K at 400 hPa

Occurrence Frequency,
Relative Humidity < 20% at 400 hPa
(NOT mean RH)

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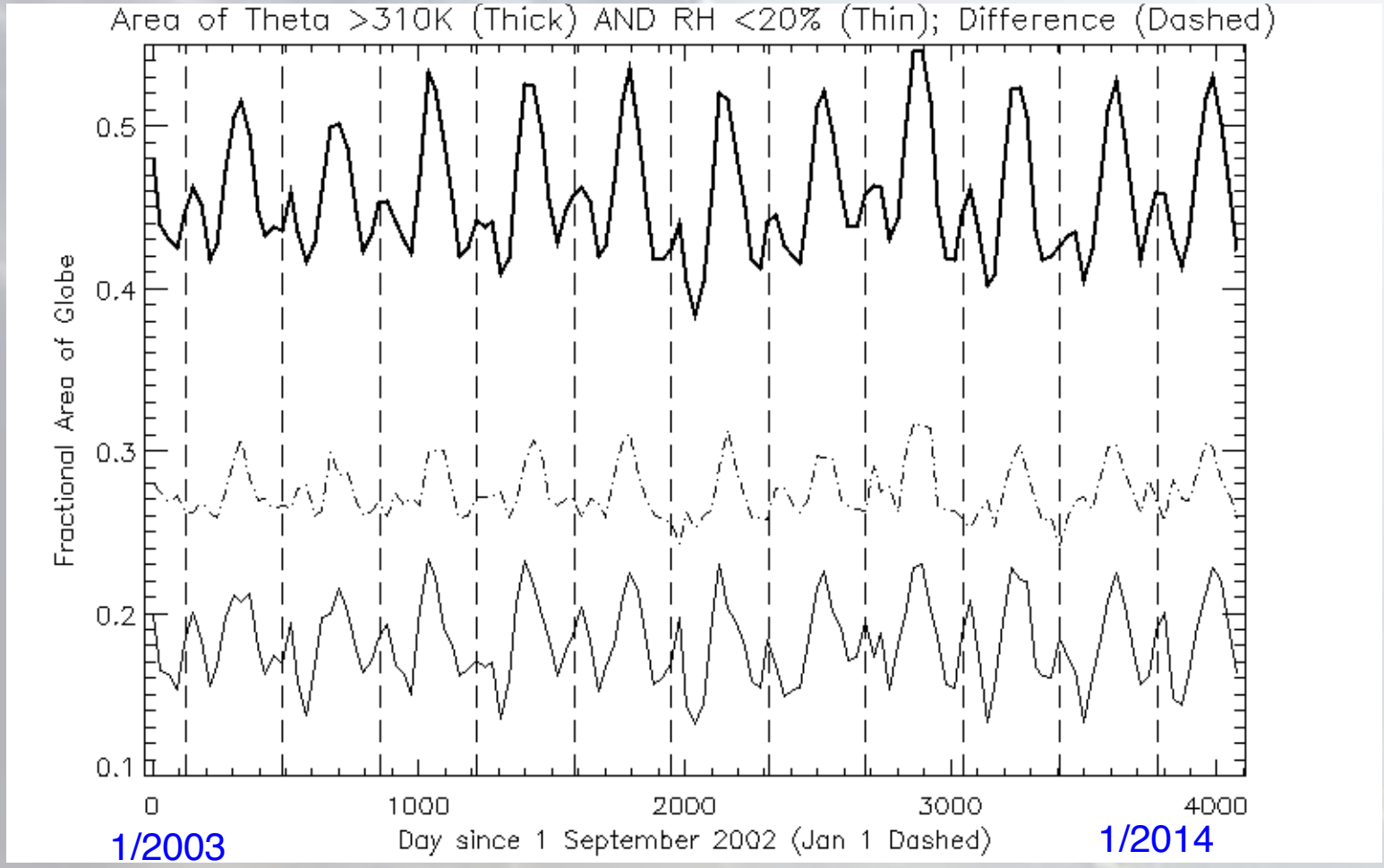
400 hPa: Occurrence Frequency Weighted Area

θ > 310 K (thick)

RH < 20% (thin)

Their difference (dashed)



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A recap

- **AIRS has most profile information in the dry subtropics, where climate processes may be driving climate sensitivity. See:**
  - ***Fasullo and Trenberth, 2013, Science.***
  - ***Sherwood et al., 2014, Nature.***

- **With 11 years of observations, AIRS likely contains useful climate indices (like relative humidity quantities) in the dry tropics and subtropics.**
  - ***Today's study is a preliminary attempt at creating one index.***

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Next Steps

- **Derive some *global* metrics (including height) to distinguish tropics from subtropics.**
- **Propagate errors along with summaries (like means).**
- **Create clearer hypotheses of how they may be varying**
  - ***E. g. tropical expansion***
- **Look at those quantities over nearly 12 years of observations.**